

REMARKS

Claims 1-5 and 7-14 were pending in the application. In the Office Action mailed January 4, 2010, claims 1-5, 7 and 14 are rejected and 8-13 are objected to as depending on a rejected base claim but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. In the instant Amendment, claim 7 has been cancelled without prejudice, and claims 1 and 14 have been amended. Upon entry of the instant Amendment, claims 1-5 and 8-14 will be pending in the application. The amendments are proper in that they place the application in condition for allowance or in better form for appeal.

Claim 1 has been amended to recite that the one or more ultrasonic indenters vibrate in a plurality of different angles. Support for this amendment can be found in the specification, e.g., at page 7, lines 22-27.

Claim 14 has been amended to delete the recitation of the term "sufficiently."

No new matter has been added by the amendment. Entry of the foregoing amendment and consideration of the following remarks are respectfully requested.

Rejection under 35 U.S.C. § 112, second paragraph

Claims 7 and 14 are rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. To expedite prosecution of the current application, claim 7 has been canceled and claim 14 has been amended in accordance with the Examiner's suggestion. Thus, these rejections are now rendered moot.

Rejection Under 35 U.S.C. § 103

Claims 1-5, 7 and 14 are rejected under 35 U.S.C. § 103(a) as being unpatentable over **Statnikov** (US 6,338,765) in view of **Lu** (K. Lu, *Nanocrystalline metals crystallized from amorphous solids: nanocrystallization, structure, and properties*, Materials Science and Engineering, R16 (1996) p. 161-221) and **Wang** (X.Y. Wang and D.Y. Li, *Mechanical and electrochemical behavior of nanocrystalline surface of 304 stainless steel*, Electrochimica

Acta, 47, (2002), p. 3939-3947).

Amended claim 1 provides a method of producing a steel product having a nanocrystallized surface layer using ultrasonic impact treatment followed by heat treatment to cause precipitation of nanocrystals. Specifically, the ultrasonic impact treatment is conducted by impacting the surface of the steel at a plurality of different directions using one or more ultrasonic indenters, where the one or more ultrasonic indenters vibrate in a plurality of different angles.

As previously discussed, impacting the steel sheet at a plurality of directions by ultrasonic indenters vibrating in a plurality of different angles is depicted in several embodiments. For example, Figure 1 shows indenters are set at different angles with respect to the surface as exemplified by Z₁, Z₂, and Z₃ and described at page 6, lines 8-12. In this embodiment, each indenter vibrates in a different angle and impacts the surface from a different direction. Also, Fig. 2 shows indenters arranged at angles of 120° from each other. Additionally, Fig. 4 embodies indenters vibrating simultaneously in a plurality of directions, namely: Z4, (i.e., vertical) and Z5 (i.e., horizontal). See, the specification at the paragraph bridging pages 8 and 9. In this embodiment, the simultaneously horizontal and vertical vibrations combine to result in vibration in a plurality of different angles and therefore impacting the surface in a plurality of different directions. The specification also states that “the angles of the plurality of vibration directions are not limited, but impact is applied from as different directions as possible.” See, specification, at p. 7, ll. 22-25.

In contrast, Statnikov teaches an ultrasonic treatment in which the indenter impacts the surface in one direction, e.g., the vertical direction, by conventional vibration, e.g. vibrating up and down. However, the present specification states that:

[i]n working by impacting making ultrasonic indenters vibrate in only one direction, the structure of the surface layer of the metallic product is developed, the crystal grains do not become equiaxial, and the crystal grains deform to pancake shapes.

See, the specification, at page 6, ll. 15-19. Thus, the ultrasonic treatment of Statnikov would be expected to have resulted in an undesired, pancake grain shape, and not have provided the claimed equiaxial microstructure.

The Examiner has suggested that Statnikov's disclosure of an ultrasonic transducer head 20 moved in a desired scanning pattern 24 over the steel surface teaches impacting steel at a plurality of directions since allegedly the indenters will have a horizontal component relative to the workpiece due to the scanning action as well as a vertical component due to the up and down vibration of the indenters. See, Office Action at page 4 and page 9. However, Statnikov does not teach or suggest an indenter scanning while simultaneously impacting the steel surface. Instead, Statnikov teaches a "step by step movement along a specified path" of the surface scanning tool. See, Statnikov at column 13, lines 12-18. Thus, the Statnikov indenters would first scan to the predetermined position, then impact the surface, then scan to the next position in a step by step process that results in impacting the steel surface in the conventional downward direction. Regardless of this distinction, the present claims have been amended to recite that the indenters vibrate in a plurality of different angles. Statnikov does not teach or suggest that the ultrasonic indenters vibrate in a plurality of different angles.

The Examiner cites Lu for teaching a basic principle for crystallizing ultrafine crystallites, in particular nanocrystals. Lu provides a general review of nanocrystalline metals crystallized from amorphous solids. However, only bulk properties are considered. There is no teaching or suggestion in Lu of ultrasonic treatment of the surface of a steel, much less treating the surface of a steel with ultrasonic indenters vibrating in a plurality of different angles.

The Examiner cites Wang for teaching annealing a nanocrystalline layer formed by sandblasting at 350 °C for 60 minutes. However, Wang does not teach or suggest ultrasonic treatment of any kind, much less treating the surface of a steel with impacts at a plurality of different directions by ultrasonic indenters vibrating in a plurality of different angles.

Since neither Lu nor Wang teach or suggest a method in which a steel surface is impacted in a plurality of directions by one or more ultrasonic indenters, neither of these references supplies what are missing in Statnikov.

Therefore, claims 1-5, and 14 are not obvious under 35 U.S.C. § 103(a) over Statnikov, Lu, and Wang, either individually or in combination.

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the

application, as amended, be allowed and passed for issue.



Respectfully submitted,

KENYON & KENYON LLP

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By: Weining Wang
Weining Wang
Reg. No. 47,164

KENYON & KENYON LLP
One Broadway
New York, NY 10004
Telephone No. (212) 425-7200
Facsimile No. (212) 425-5288
CUSTOMER NO. 26646